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The effects of melt-SCLM interactions on the $\delta^{18}O$ value of primary mantle-derived magmas constrained using kimberlitic megacrysts

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The $\delta^{18}O$ values of primary mantle-derived magmas are ~5.7‰ (5.0-5.5‰ for olivine) unless recycled crust is present in the source or if the magma assimilates crustal material *en route* to the surface. Kimberlitic megacrysts are large (>1 cm) crystals that are thought to have crystallized from sub-lithospheric proto-kimberlite melts at the base of the subcontinental lithospheric mantle (SCLM) during complex melt-SCLM interactions. Thus, these megacrysts represent an excellent opportunity to constrain the effects of SCLM assimilation on the $\delta^{18}O$ values of primary mantle-derived melts. We present laser fluorination $\delta^{18}O$ values for a well-characterized suite of megacrysts from the Monastery kimberlite, South Africa, to: (1) constrain the $\delta^{18}O$ value of the mantle source and (2) evaluate the effects of melt-SCLM interactions on the $\delta^{18}O$ value of mantle-derived magmas.

The main-silicate megacrysts ("MST"; garnet, clinopyroxene, orthopyroxene) crystallise first and have $\delta^{18}O$ values of 5.10 to 5.78‰. The Fe-poor olivines (Fo_{83-88}) have a restricted normal mantle range at $\delta^{18}O$ of 5.05 to 5.42‰ and show no correlation with Mg# or Ni, whereas the Fe-rich olivines (Fo_{78-83}) range from 4.53 to 4.94‰ and show positive correlations with Mg# and Ni. Monastery ilmenite megacrysts have been grouped based on their Cr and Mg content. Group I ilmenites (Cr-, Mg-poor) range from 3.88 to 4.35‰, Group II ilmenites (Cr-rich, Mg-poor) range from 2.74 to 4.46‰, and Group III ilmenites (Cr- and Mg-rich) range from 2.93-4.05‰. The Group I ilmenites show a positive correlation of $d^{18}O$ value with Cr#, whereas the Group II and III ilmenite $d^{18}O$ values show no correlation with Cr#. These variations suggest that the parent melt evolved within an open-system in the SCLM with two distinct changes in $\delta^{18}O$ when rising to the surface.

We propose that the Monastery proto-kimberlite originated from a convecting mantle source that has a mantle-like $\delta^{18}O$, and that lower $\delta^{18}O$ values in the Fe-rich olivines and Group 2 ilmenites can be explained by stages of SCLM assimilation or equilibration including a combination of low-$\delta^{18}O$ eclogite and Cr-rich metasomatic veins. The increase in $\delta^{18}O$ in the Group 3 ilmenites may be explained by the assimilation of high-$\delta^{18}O$ metasomatised peridotite.